Name _____ AP Chemistry

Calorimetry: Measurement of Heat Energy

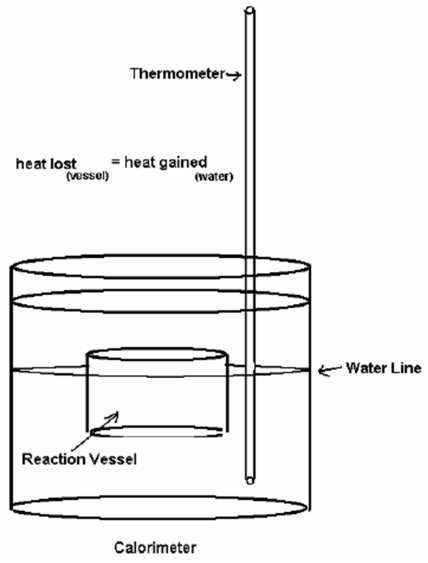
The amount of energy released or absorbed by a chemical reaction can be measured using a calorimeter. This information is essential to understanding the stability of chemical compounds, predicting equilibrium concentrations in chemical reactions, and identifying conditions for a reaction to occur efficiently and safely. In this activity you will learn how the energy change in a chemical reaction can be measured using a calorimeter.

Information

- Heat is the energy associated with the random motion of particles.
- The unit for Heat Energy is the Joule (J).
- Kinetic Energy is the energy associated with the motion of atoms and molecules.
- Temperature is a measure of the energy in a sample of material.
- The symbol ΔT refers to "the change in temperature." Example: $\Delta T = 5.00°C$ means a temperature change of 5°C.
- Heat Capacity is the energy required to raise the temperature of a 1 g sample of a substance 1°C (or 1 Kelvin degree).
- The specific heat capacity for water is 4.18 Joule/gram Kelvin degree.

Model

Assume that a calorimeter is a closed system where all the energy released by an exothermic change is absorbed by the water in the calorimeter. If the mass of the water is known, the temperature change of the water can be used to determine the amount of heat energy released.



Equation for the calculation of heat is: $q = mC\Delta T$

- q = heat released in Joules
- m = mass of water in the calorimeter
- C = specific heat capacity (not °C which is a temperature)
- ΔT = [final temperature – initial temperature] (absolute value)

1) What is the numerical value and units of the specific heat capacity of water?

2) What information does the specific heat capacity of water provide?

Answer questions 3-7 based on the following passage:

A calorimeter was used to measure the heat released by a chemical change. The calorimeter contained 100.00 g of water at an initial temperature of 10.0°C. When the reaction was finished the temperature of the water increased to 75.0°C.

3) Write the mass of the water (m) indicated in the passage.

4) Write the change in temperature (ΔT) indicated in the passage.

5) Write the correct mathematical setup for the calculation of heat (q). (Substitute the appropriate values for m, C and ΔT in the equation.)

6) What is the heat quantity released by the chemical change?

7) If a substance with a larger specific heat than water were used in the experiment, identify whether ΔT would be larger or smaller. Explain.

8) Determine the heat required to raise the temperature of a 50. g sample of water from 10°C to 45°C.

9) Determine the mass of a water sample that is heated from an initial temperature of 25°C to a final temperature of 100°C following the addition of 1200 J of heat energy.

10) A 100 g sample of pure lead is heated from 10.0°C to 197.5°C by the addition of 3000 J of heat energy. Calculate the specific heat capacity of lead.

11) The specific heat (C) of water is quite high compared to the specific heat of lead, so the energy released by a sample of heated lead to its surroundings will be only around 4% of the amount of heat released by an equal mass of water under identical conditions.
   (a) Calculate the change in temperature that results from the addition of 2500 J of heat energy to a 25g sample of water.
   (b) Calculate the change in temperature that results from the addition of 2500 J of heat energy to a 25g sample of lead.
   (c) Explain the difference in the temperature changes, found in parts (a) and (b), in terms of the specific heat capacities of lead and water.